## drought tips

Number 92-56

## How Much Water Are You Applying With Your Low Volume Irrigation System?

During a drought it is particularly important to use only the amount of water necessary for irrigation. Irrigation scheduling, which defines how much to irrigate, is only the first step of irrigation. Once the amount to apply is known, how long the low volume irrigation system should be operated must be determined. Because low volume irrigation systems are easy to operate and can achieve a high degree of uniformity, they are well-suited to drought strategies such as deficit irrigation.

To determine how long the system should operate, it is first necessary to calculate the application rate. Irrigation scheduling and crop water use information is most frequently

presented in inches per day (in./day), while discharge from low volume emitters is measured in gallons per hour (gph). The following may be helpful in determining required operating times for low volume irrigation systems.

## **Drip and Micro-Sprinkler Emitters**

The water use of the crop and the application rate of the emission device(s) determines how long drip and micro-sprinklers should be operated.

Step 1 in determining the required operating time is to convert the crop water use information (usually available in inches per day), to gallons per day of plant

Table 1. Crop water use (gal./ day) for various plant spacings and crop water use (in. / day).

## Crop Water Use (in. / day)

	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4
100	3	6	9	12	16	19	22	25
200	6	12	19	25	31	37	44	50
400	12	25	37	50	62	75	87	100
600	19	37	56	75	93	112	131	150
800	25	50	75	100	125	150	174	199
1000	31	62	93	125	156	187	218	249
1200	37	75	112	150	187	224	262	299
1400	44	87	131	174	218	262	305	349
1600	50	100	150	199	249	299	349	399
1800	56	112	168	224	280	336	392	449
2000	62	125	187	249	311	374	436	496
2200	69	137	206	274	343	411	480	548
2400	75	150	224	299	374	449	523	596
	200 400 600 800 1000 1200 1400 1600 1800 2000	100 3 200 6 400 12 600 19 800 25 1000 31 1200 37 1400 44 1600 50 1800 56 2000 62	100     3     6       200     6     12       400     12     25       600     19     37       800     25     50       1000     31     62       1200     37     75       1400     44     87       1600     50     100       1800     56     112       2000     62     125       2200     69     137	100       3       6       9         200       6       12       19         400       12       25       37         600       19       37       56         800       25       50       75         1000       31       62       93         1200       37       75       112         1400       44       87       131         1600       50       100       150         1800       56       112       168         2000       62       125       187         2200       69       137       206	100       3       6       9       12         200       6       12       19       25         400       12       25       37       50         600       19       37       56       75         800       25       50       75       100         1000       31       62       93       125         1200       37       75       112       150         1400       44       87       131       174         1600       50       100       150       199         1800       56       112       168       224         2000       62       125       187       249         2200       69       137       206       274	100       3       6       9       12       16         200       6       12       19       25       31         400       12       25       37       50       62         600       19       37       56       75       93         800       25       50       75       100       125         1000       31       62       93       125       156         1200       37       75       112       150       187         1400       44       87       131       174       218         1600       50       100       150       199       249         1800       56       112       168       224       280         2000       62       125       187       249       311         2200       69       137       206       274       343	100       3       6       9       12       16       19         200       6       12       19       25       31       37         400       12       25       37       50       62       75         600       19       37       56       75       93       112         800       25       50       75       100       125       150         1000       31       62       93       125       156       187         1200       37       75       112       150       187       224         1400       44       87       131       174       218       262         1600       50       100       150       199       249       299         1800       56       112       168       224       280       336         2000       62       125       187       249       311       374         2200       69       137       206       274       343       411	100       3       6       9       12       16       19       22         200       6       12       19       25       31       37       44         400       12       25       37       50       62       75       87         600       19       37       56       75       93       112       131         800       25       50       75       100       125       150       174         1000       31       62       93       125       156       187       218         1200       37       75       112       150       187       224       262         1400       44       87       131       174       218       262       305         1600       50       100       150       199       249       299       349         1800       56       112       168       224       280       336       392         2000       62       125       187       249       311       374       436         2200       69       137       206       274       343       411       480

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water use. The following formula may be used (or see Table 1):

Water Use by Plant Crop
the Plant = Spacing x Water Use x 0.623
(gal./day) (ft²) (in./day)

For example: Tree crop spacing = 20 ft. x 20 ft. = 400 ft<sup>2</sup>

Crop water use = 0.3 in./day

Water use by

the plant =  $400 \text{ ft}^2 \times 0.3 \text{ in./day} \times 0.623$  (gal./day)

= 75 gal./day

Step 2 is to determine the application rate of the irrigation system in gallons per hour (gal./hr.). For both drip emitters and micro-sprinklers, this requires determining: (1) the number of emission devices per plant, and (2) the discharge rate per emission device (gal./hr./emitter):

Application Number of Discharge Rate per
Rate = Emission x Emission Device
(gal./hr.) Devices (gal./hr./ emitter)

For example:

Drip emitters: 4 drip emitters per tree
Discharge rate per emitter = 1 gal./hr.
Application rate = 4 emitters/tree x 1 gal./hr. per
emitter (gal./hr.)
= 4 gal./hr.

Micro-sprinklers:

Discharge rate per micro-sprinkler = 12 gal./hr.

Application rate = 1 micro/tree x 12 gallons/hour
(gal./hr.)

= 12 gal./hr.

Step 3 is to determine the operation time of the irrigation system in hours per day. This requires using the crop water use (determined in Step 1) and the application rate (determined in Step 2). The following formula may be used (or see Table 2):

Hrs. of operation = Crop water use + Application rate per day (hrs /day) (gal./day) (gal./hr)

Table 2. Hours of operation per day for various application rates (hrs./ day) and crop water use (gal./ day).

Application Rate (gal. / hr.)

						***					
	1	2	4	6	8	10	12	14	16	18	20
5	5.0	2.5	1.3								
10	10.0	5.0	2.5	1.7	1.3	1.0					
15	15.0	7.5	3.8	2.5	1.9	1.5	1.3	1.1			
25		12.5	6.3	4.2	3.1	2.5	2.1	1.8	1.6	1.4	1.3
50			12.5	8.3	6.3	5.0	4.2	3.6	3.1	2.8	2.5
75			18.8	12.5	9.4	7.5	6.3	5.4	4.7	4.2	3.8
100				16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0
125				20.8	15.6	12.5	10.4	8.9	7.8	6.9	6.3
150					18.8	15.0	12.5	10.7	9.4	8.3	7.5
175					21.9	17.5	14.6	12.5	10.9	9.7	8.8
200						20.0	16.7	14.3	12.5	11.1	10.0
225						22.5	18.8	16.1	14.1	12.5	11.3
250							20.8	17.9	15.6	13.9	12.5
275							22.9	19.6	17.2	15.3	13.8
300								21.4	18.8	16.7	15.0
325								23.2	20.3	18.1	16.3
350									21.9	19.4	17.5
375									23.4	20.8	18.8
400										22.2	20.0
425											21.3
450											22.5
475											23.8

Crop Water Use (gal/day) For example:

Drip emitters:

Crop water use (gal./day) = 75 gal./day (Step 1) Application rate (gal./hr.) = 4 gal./hr. (Step 2) Hrs. of operation = 75 gal./day + 4 gal./hr. per day (hrs./day)

= 18.8 hrs. /day

Micro-sprinklers:

Crop water use (gal./day) = 75 gal./day Application rate (gal./hr.) = 12 gal./hr.

Hrs. of operation = 75 gal./day + 12 gal./hr per day (hrs./day)

= 6.3 hrs./day

(Table 2 reveals the same hours of operation for these examples.)

**Drip Tapes and Tubings** 

Drip tapes and tubings placed on the soil surface or subsurface are commonly used for row crops. Determining daily operation times for these systems is somewhat more complicated than for drip emitters and micro-sprinklers, but follows a similar three-step process. The discharge rate of drip tapes and tubings is usually given in gallons per minute per 100 feet of material (gal./min. per 100 ft.).

Step 1 is to determine the crop water use in inches per day (in./day), which is the standard measure used in evapotranspiration (ET)-based methods of irrigation scheduling.

Step 2 is to determine the application rate of the drip tape or tubing in inches per hour (in./hr.). Table 3 can be used to make this determination if the row spacing and the irrigation system application rate (gal./min.per 100 feet) are known.

Example: Row spacing = 60 inches

Drip tape application rate = 0.5 gal./min. per

100 ft.

From Table 3, the application rate (in./hr.) = 0.1 in./hr.

Table 3. Application rate (in. / hr.) of drip tapes and tubings for various flow rates and spacings

Flow Rate (gal. / min. per 100 ft.)

		0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50
Ì	10	●.12	0.17	●.23	0.29	0.35	0.40	9.46	0.52	0.58
Ì	15	0.08	●.12	<b>0.15</b>	0.19	0.23	0.27	0.31	●.35	0.39
Ì	20	0.66	<b>9.09</b>	0.12	0.14	0.17	0.20	€.23	0.26	0.29
Ì	25	0.05	9.07	1.09	€.12	0.14	0.16	<b>0.18</b>	♦.21	0.23
	30	0.64	0.06	0.08	0.10	0.12	0.13	0.15	0.17	0.19
,	35	0.03	0.05	0.07	0.08	0.10	0.12	♦.13	0.15	●.17
ng )	40	0.03	0.04	0.66	0.07	0.09	6.10	0.12	♦.13	0.14
	45	0.03	0.04	♦.♦5	0.66	0.08	0.09	0.10	0.12	0.13
	50	0.02	0.03	0.05	0.06	0.07	9.05	0.09	0.10	0.12
	55	0.02	0.03	0.04	0.05	0.06	0.07	0.05	0.09	0.11
	60	0.02	0.03	0.04	0.05	0.06	0.07	0.08	9.09	0.10
	65	0.02	0.03	9.94	0.04	0.05	0.66	0.07	0.06	0.69
	70	0.02	0.02	0.03	0.04	0.05	0.66	0.07	0.07	9.06
	75	0.02	0.02	0.03	0.04	0.05	€.€5	0.06	0.07	4.06
	80	0.01	0.02	0.03	0.04	0.04	0.05	1.66	0.06	0.07

Row Spacin (in.)

Step 3 is to determine the irrigation system operation time (hours) necessary to satisfy the crop water needs. This requires the crop water use (determined in Step 1), and the application rate (determined in Step 2). The following formula may be used (or see Table 4):

Example: Crop water use = 0.3 in. /day
System application rate = 0.1 in. /hr
Hrs. of operation = 0.3 in. /day + 0.1 in./hr
per day (hrs./day)

Hrs. of = operation per day (hrs./day)

Plant water use

(in./day)

Application rate (in./hr.)

= 3 hrs./day

Table 4 reveals the same operation time for this example.

Table 4. Operation time (hrs / day) for various application rates (in. / hr.) and crop water use (in. / day)

	positivitive			. ,	Appucati	on Rate (in	. / h=.)		· · · · · · · · · · · · · · · · · · ·		
Plant Water Use (in. / day)		0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
	.05	1.0	●.5	0.3	0.3	6.2	<b>0.2</b>	0.1	e.1	9.1	0.1
	0.1	2.0	1.0	<b>0.7</b>	0.5	9.4	0.3	9.3	0.3	0.2	0.2
	0.15	3.0	1.5	1.0	9.6	0.6	0.5	0.4	9.4	9.3	0.3
	0.2	4.0	2.0	ĭ.3	1.0	0.8	9.7	0.6	0.5	0.4	0.4
	0.25	5.0	2.5	1.7	1.3	1.0	0.8	<b>Q.7</b>	0.6	0.6	0.5
	0.3	6.0	3.0	2.0	1.5	1.2	1.0	0.9	9.8	9.7	9.6
	0.35	7.0	3.5	2.3	1.8	1.4	1.2	1.0	0.9	9.8	0.7
	0.4	8.6	4.0	2.7	2.0	1.6	1.3	1.1	1.0	0.9	0.8

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